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Skilled Migration and Scientific and Technical Potential of Regional Labour Markets: Evidence from the Kyrgyz Republic

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Abstract

The purpose of this study was to substantiate a model for the adaptive regulation of the regional labour market aimed at preserving scientific and technical potential under conditions of increasing migration mobility. The research drew upon official statistical data for 2020–2024, a comparative analysis of regional funding for educational programmes and graduate employment outcomes, and an assessment of the extent to which qualified personnel were covered by digital verification tools.

The findings revealed marked interregional disparities. Bishkek recorded the highest level of funding (KGS 164.2 million) and the largest share of employed graduates (61.4%). In contrast, the Talas and Batken regions demonstrated significantly lower indicators: funding did not exceed KGS 31.5 million and KGS 38.9 million, respectively, while graduate employment remained at 34.5% and 36.8%. The average growth rate of digitally verified qualifications also varied substantially, ranging from 23.2% to 78.5% across regions. Bishkek again showed the highest increase, whereas Batken reached only 42.5%.

In response to these disparities, the study proposed a conceptual model integrating four key components: regional human resource forecasting, digital certification of qualifications, institutional mechanisms to stimulate mobility and return migration, and the development of knowledge transfer infrastructure. This model provides a structured framework for enhancing regional employment policy by improving the efficiency of investments in human capital and supporting the digital transformation of managerial decision-making.

The results of the study may be utilised by public authorities of the Kyrgyz Republic, regional vocational education centres, and analytical units in designing employment strategies and optimising budgetary interventions aimed at strengthening scientific and technical capacity in the context of ongoing migration dynamics.

Keywords: Digital Verification; Interregional Differences; Personnel Policy; Demographic Factors; Institutional Capacities; Experience Indexation; Kyrgyz Republic

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Introduction

Structural transformations within the Kyrgyz labour market have been accompanied by rising migration mobility among individuals with scientific and technical qualifications, resulting in the loss of intellectual capital in regions lacking sufficient institutional support. Unequal access to vocational training programmes, marked differences in graduate employment outcomes, and limited coverage of digital qualification verification across administrative units complicate effective regional employment planning. Asymmetric funding, fragmented implementation of educational policy, and the absence of mechanisms for forecasting human-resource needs, combined with the lack of a unified e-verification platform, impede the integration of scientific and technological potential into local development strategies. These trends underscore the need for a renewed scientific approach to regional employment regulation, one that accounts for the mobility of intellectual resources and the differentiated effectiveness of educational programmes. The implications extend beyond labour market dynamics, shaping broader patterns of regional inequality and socio-economic development.

Existing research on regional labour markets and migration may be grouped into several analytical strands. Studies on migration and human-capital mobility emphasise the profound influence of migration flows on labour-market stability and regional development. Lupak et al. (2022) demonstrate that regulatory effectiveness increases when economic and demographic factors are considered jointly, while Sardak et al. (2021) highlight the circular nature of youth migration and the limitations of fragmented regulatory approaches. Dzhooshebekova et al. (2021) further link migration intensity in Kyrgyzstan to shifts in socio-economic policy, indicating the structural character of labour mobility.

A second strand addresses digital transformation and structural change in labour markets. Bender (2024) shows that digitalisation intensifies labour-market segmentation and

increases demand for highly skilled labour. Su et al. (2022) and Shen (2024) demonstrate that technological change reshapes sectoral employment and alters the structure of professional skills.

Recent scholarship expands this discussion by examining digital labour mobility, remote work, and online employment platforms. Schoenberg et al. (2025) argue that remote working formats partially substitute for physical relocation while simultaneously intensifying competition across regional labour markets. Triandafyllidou (2026) shows that digital labour platforms reconfigure traditional migration trajectories, as professional activity increasingly transcends national and regional boundaries. These developments introduce additional complexity into state regulation, as labour mobility is no longer fully captured by conventional migration statistics or institutional frameworks.

Institutional and policy dimensions of labour-market regulation are explored by Tulegenov (2024), who emphasises the role of international agreements, and Korobkov (2024), who identifies cross-country differences in migration governance within the Eurasian Economic Union. Nasyrov (2022) highlights weak coordination between public-sector reforms and regional labour policies, while Kuldasheva (2024) notes that regulatory fragmentation limits migrant integration. Comparative evidence suggests that successful migrant integration depends on regional training systems and labour-market flexibility (Dorn & Zweimüller, 2021), while migration diversity is associated with innovation and economic productivity (Ozgen, 2021).

However, the reviewed studies tend to analyse migration dynamics and digital transformation separately, limiting comprehensive understanding of the relationship between technological adaptation, migration pressures, and the effectiveness of regional employment policies. Insufficient attention has been paid to regional disparities in vocational-training funding and to mechanisms for digital certification of qualifications at the subnational

level. Moreover, indicators of human-capital mobility—particularly reverse migration—have not been integrated into analytical models, restricting the practical application of human-resource integration concepts in the context of structural labour-market change.

In this study, regulatory mechanisms are conceptualised as policy instruments shaping regional labour-market outcomes under conditions of migration pressure. These mechanisms are grouped into three categories:

- **Fiscal instruments**, including public funding of vocational education and targeted investment in human capital.
- **Institutional instruments**, such as digital certification systems and labour-market coordination frameworks.
- **Mobility-related instruments**, including policies supporting return migration and regional workforce redistribution.

This classification clarifies how regulatory tools intersect with migration processes and contribute to the preservation of scientific and technical potential.

The study aimed to identify mechanisms for the adaptive regulation of the regional labour market in the Kyrgyz Republic, taking into account spatial differences in digital qualification verification, vocational-training financing, and employment outcomes. The study pursued three objectives: (a) to conduct a spatial analysis of regional disparities in vocational-training funding and graduate employment across nine administrative-territorial units; (b) to assess the coverage of digital certification of qualified personnel, considering sectoral training specifics, types of educational institutions, and regional digital accessibility; and (c) to classify regions according to human-resource potential using indicators of institutional capacity, digitalisation levels, and adaptability to structural labour-market change. In the next section, we discuss the methodological framework.

Methodological Framework

The study adopted an applied analytical and empirical design and covered the period from 2020 to 2024. Its spatial boundaries encompassed nine administrative-territorial units of the Kyrgyz Republic—Bishkek city, Osh city, and the regions of Chui, Jalal-Abad, Issyk-Kul, Naryn, Batken, Talas, and Osh. These regions were selected to reflect the country's socio-economic, educational, and demographic differentiation. The sample thus included major urban centres with high concentrations of human capital (Bishkek and Osh), alongside predominantly rural regions characterised by limited access to vocational education and digital services. This ensured a comprehensive assessment of territorial disparities in employment policy implementation.

The chronological scope of the study made it possible to trace regional shifts in vocational-training financing, graduate employment rates, and the prevalence of digital qualification verification as part of the structural transformation of the labour market. A comparative dimension was added through the inclusion of four Central Asian countries: Kyrgyzstan, Kazakhstan, Uzbekistan, and Tajikistan, chosen for their comparable institutional environments, migration dynamics, employment-regulation models, and shared historical patterns of labour mobility. This provided a representative basis for analysing regional approaches to human-capital development and digital labour certification. International models of skilled-professional reintegration were also considered, including the German Academic Exchange Service (2025), analogous initiatives in the Republic of Korea and India (Agrawal et al., 2011), and estimates from the International Organization for Migration (2021) on global trends in return migration.

The analytical framework was constructed using statistical materials from the Ministry of Labour, Social Protection and Migration of the Kyrgyz Republic (2025) and the National Statistical Committee of the Kyrgyz Republic (2024). Additional data were drawn from the Bureau of

National Statistics of Kazakhstan (2025), the State Committee of the Republic of Uzbekistan on Statistics (2024), and the Agency on Statistics under the President of the Republic of Tajikistan (2024). International databases provided further comparative indicators: external labour-migration volumes (International Organisation for Migration, 2021; 2024), remittance flows to Kyrgyzstan (World Bank, 2023), migrant distribution by education and specialisation (UNESCO, 2026), and mobility indicators for highly skilled personnel (German Society for International Cooperation, 2025; OECD, 2023; UNDP, 2023).

These sources enabled a multi-layered analysis of regional labour-market transformation under conditions of heightened migration mobility. National data from the Ministry of Labour, Social Protection and Migration (2025) supplemented the dataset with information on state funding for vocational-training programmes, graduate numbers by field of study, subsequent employment outcomes, and the coverage of digital certification mechanisms. Regulatory documents—including the *Concept of Digital Transformation of the Kyrgyz Republic for 2024–2028* (2024), the *National Development Programme until 2026* (2023), and the *National Development Strategy for 2018–2040* (2018)—provided the institutional context for assessing employment parameters and the digitalisation of qualification verification.

The study employed comparative analysis to examine regional indicators of vocational-training funding, graduate employment rates, and the pace of digital

qualification verification across the nine administrative-territorial units. Five regional gradations of employment (under 30%, 30–44%, 45–59%, 60–74%, and over 75%) were identified, enabling the detection of consistently vulnerable areas and regions with higher adaptive capacity. We also assessed asymmetries in educational-programme funding per unemployed person.

Structural analysis was used to determine the proportion of specialists who underwent digital qualification verification, with coverage categorised as low (up to 20%), medium (21–50%), and high (over 50%). These gradations were applied across training fields (agricultural, technical, social), types of educational institutions (secondary vocational, higher), and levels of occupational demand within regional labour-market structures.

Elements of factor analysis were incorporated to integrate key variables into a multidimensional system for assessing regional labour-market adaptability. An analytical model was developed comprising four blocks: average annual vocational-training funding, graduate employment rate, level of digital qualification certification, and type of regional economy (mono-functional or diversified). Based on these calculations, a typology of regions was constructed, identifying three clusters: high human-resource potential, medium adaptability, and systemically vulnerable areas.

To ensure methodological transparency, the regional labour-market adaptability index was defined as:

$$AI = \frac{F + E + D}{3}$$

where *AI* denotes the adaptability index; *F* represents vocational-training funding (per capita or per unemployed person); *E* denotes graduate employment rates; and *D* reflects digital certification coverage. All variables were normalised to ensure comparability across regions.

The impact of migration on scientific and technical potential was estimated using the functional relationship:

$$P = (H_{in} - H_{out}) \times T$$

where P denotes scientific and technical potential; $H_{(in)}$ represents the inflow of highly skilled labour; $H_{(out)}$ denotes the outflow of qualified personnel; and T reflects the technological absorption capacity of the regional labour market. In empirical application, $H_{(out)}$ was approximated by the share of emigrating graduates, while T was proxied by employment rates and digital-certification coverage. Higher values of P indicate stronger regional capacity to retain and reproduce scientific and technical potential under migration pressure.

Interpretation of the results was based on correlating calculated indicators with regional labour-market contexts, enabling assessment of the consistency between institutional support and actual employment outcomes. Absolute and relative indicators were compared with attention to internal regional variability and temporal dynamics. Correlation coefficients between digital-certification coverage and employment rates were calculated, revealing positive associations in regions with advanced digitalisation of vocational-training infrastructure.

To validate the analytical framework, Pearson correlation coefficients were computed for key variables: digital-certification coverage, graduate employment rates, and vocational-training funding, across regions for 2020–2024. This approach enabled the identification of statistically consistent patterns in the interaction between institutional capacity, digitalisation, and labour-market outcomes.

Results

Theoretical and Methodological Approaches to Assessing the Relationship between Labour Migration, Regional Labour Market, and Intellectual Potential

One of the principal indicators for assessing the impact of migration processes on regional labour markets is the level of emigration among individuals with higher education, particularly those trained in technical, information-technology, and medical fields. This indicator is especially significant in the context of the countries examined in the study, namely Kyrgyzstan, Kazakhstan, Uzbekistan, and Tajikistan, where a persistent shortage of highly skilled personnel is evident in strategically important sectors of the economy. The departure of specialists with applied and

analytical competencies complicates the modernisation of national economies and increases reliance on external knowledge resources.

To quantify the scale of intellectual losses, a comparative analysis was conducted of the proportion of higher-education graduates who emigrated during the first year after graduation between 2020 and 2024. The results of this analysis are presented in Table 1.

The analysis of Table 1 indicates a consistent upward trend in the emigration of higher-education specialists in the countries examined during 2020–2024. The year-over-year dynamics also reveal a steady increase in emigration rates across all fields, with the most pronounced annual growth observed among graduates in information technology. These processes were particularly evident among IT specialists, whose high mobility reflects strong international demand. In Kyrgyzstan, the proportion of emigrants among IT graduates reached 45.3 per cent in 2024, while in Tajikistan it stood at 41 per cent, signalling the loss of a substantial share of human capital immediately after completion of the educational cycle.

Kazakhstan recorded the lowest indicators among the countries under study. In 2024, the share of emigrants was 14.1 per cent for engineering, 22.3 per cent for information technology, and 10.8 per cent for medical sciences. These dynamics may suggest comparatively greater institutional capacity to retain qualified graduates, together with a more stable internal labour market that supports the integration of young professionals into the national economy. Uzbekistan demonstrated rising emigration rates across all three key fields. In 2024, the share of emigrants reached 31.2 per cent among IT graduates, 21.8 per cent among

engineering graduates, and 14.5 per cent among medical personnel. This trend reflects increasing mobility among highly skilled graduates in a context of employment rates below 50 per cent for young specialists and limited absorption capacity within domestic labour markets. It also

suggests a growing orientation of the training system towards external labour demand. The continued moderate level of out-migration among medical specialists indicates relatively stable domestic demand, reflected in lower emigration rates of 10 to 14 per cent.

Table 1: Emigration Rates of Graduates with Higher Education by Field of Study in the Analysed Countries, 2020-2024 (% of Total Graduates in the Respective Field)

Country / Year	Field of study	2020	2021	2022	2023	2024	Change (2020-2024), %
Kyrgyzstan	Engineering sciences	28.6	31.4	33.9	36.5	39.1	36.7%
	Information technology	34.2	37.8	40.1	42.6	45.3	32.5%
	Medical sciences	19.8	21.5	23.0	24.7	26.2	32.3%
Kazakhstan	Engineering sciences	11.2	12.0	12.6	13.4	14.1	25.9%
	Information technology	17.4	18.1	19.6	20.9	22.3	28.2%
	Medical sciences	8.7	9.1	9.5	10.2	10.8	24.1%
Uzbekistan	Engineering sciences	14.5	16.7	18.1	20.4	21.8	50.3%
	Information technology	22.3	24.9	27.1	29.5	31.2	39.9%
	Medical sciences	10.3	11.0	12.2	13.6	14.5	40.8%
Tajikistan	Engineering sciences	25.1	27.3	28.9	30.2	31.7	26.3%
	Information technology	30.4	33.6	35.8	38.5	41.0	34.9%
	Medical sciences	11.6	12.4	13.1	14.0	14.8	27.6%

Note: the “Change 2020-2024” column shows the overall percentage change in emigration rates over the study period.

Source: compiled by the authors based on the Agency on Statistics under the President of the Republic of Tajikistan (2024), International Organisation for Migration (2024), Bureau of National Statistics (2025), National Statistical Committee of the Kyrgyz Republic (2024), State Committee of the Republic of Uzbekistan on Statistics (2024)

Even in the most stable segment, medical specialities, an increase in migration activity was observed. In Kyrgyzstan, the proportion of emigrating medical graduates rose from 19.8 per cent in 2020 to 26.2 per cent in 2024. The data presented here demonstrate high emigration rates, reaching up to 45.3 per cent among IT graduates and exceeding 30 per cent across most fields. These findings justify the need for

targeted regulatory mechanisms designed to reduce the outflow of specialists and create conditions for their professional realisation within national labour markets.

In view of these trends, further examination of migration pressure requires analysis of key parameters related to research-sector staffing, including the number of researchers and the volume of resources allocated to research. In

assessing the impact of migration on the scientific and technological potential of the countries under study, particular attention should be paid to the ratio of researchers to the employed population and to the share of Research and Development expenditure in gross domestic product. A comprehensive analysis of these indicators makes it possible to identify

structural gaps between the countries of the region and to form an understanding of their capacity to withstand intellectual depletion in the context of ongoing external migration. Table 2 presents the dynamics of these indicators in Kyrgyzstan, Kazakhstan, Uzbekistan, and Tajikistan for 2020–2024.

Table 2: Dynamics of the Number of Scientists and the Share of Research Expenditures in the Analysed Countries in 2020-2024							
Indicator / Country	2020	2021	2022	2023	2024	Change (2020-2024), %	Interpretation
Number of scientists (per 1,000 employed persons)							
Kyrgyzstan	0.36	0.35	0.33	0.32	0.31	-13.9%	Declining research capacity
Kazakhstan	1.04	1.07	1.10	1.13	1.17	12.5%	Strengthening research capacity
Uzbekistan	0.59	0.61	0.64	0.66	0.69	16.9%	Expanding research capacity
Tajikistan	0.41	0.40	0.39	0.38	0.36	-12.2%	Declining research capacity
Share of R&D expenditure (% of GDP)							
Kyrgyzstan	0.13	0.12	0.11	0.11	0.11	-15.4%	Reduced and stagnant R&D investment
Kazakhstan	0.14	0.16	0.17	0.19	0.21	50.0%	Significant increase in R&D investment
Uzbekistan	0.12	0.13	0.15	0.17	0.18	50.0%	Substantial growth in R&D investment
Tajikistan	0.09	0.09	0.09	0.10	0.10	11.1%	Moderate increase in R&D investment
Note: the “Change (2020-2024)” column shows the overall percentage change in research capacity indicators.							
Source: compiled by the authors based on the Agency on Statistics under the President of the Republic of Tajikistan (2024), International Organisation for Migration (2024), Bureau of National Statistics (2025), National Statistical Committee of the Kyrgyz Republic (2024), State Committee of the Republic of Uzbekistan on Statistics (2024).							

The analysis of Table 2 indicates uneven effectiveness of national policy efforts to sustain research capacity across the countries examined. A comparative assessment of the dynamics of the number of researchers and the level of research funding in 2020–2024 reveals differences of more than threefold between countries in key indicators such as the density of scientific personnel and the share of Research and Development expenditure. Kazakhstan demonstrates the strongest performance across both parameters. The number of researchers

reached 1.17 per 1,000 employees, and the proportion of R&D expenditure increased to 0.21 per cent of gross domestic product. Uzbekistan shows positive movement, particularly an increase in the number of researchers and a rise in R&D funding from 0.12 per cent to 0.18 per cent, which suggests gradual institutional activation in the scientific sector.

In contrast, Kyrgyzstan and Tajikistan display persistently low and, in some cases, declining values. In Kyrgyzstan, the number of researchers fell from 0.36 to 0.31 per 1,000 employed, while

R&D expenditure remained at 0.11 per cent of gross domestic product. In Tajikistan, the corresponding figures in 2024 were 0.36 researchers per 1,000 employed and 0.10 per cent of gross domestic product. These results reflect a structural gap in the capacity of the analysed countries to maintain and expand their research and development potential within an increasingly competitive global environment.

Low levels of investment and declining numbers of researchers contribute to the degradation of applied research in fields such as information technology, biomedicine, agro-technology, and energy. Insufficient investment in human capital limits the region's ability to generate innovative products, commercialise scientific developments, and participate in global value chains. These constraints intensify the migration of specialists and create a self-reinforcing cycle of intellectual depletion.

Trends in Migration Processes in the Analysed Countries and Their Impact on Regional Labour Markets in Kyrgyzstan

The regional differentiation of migration activity within Kyrgyzstan constitutes a key analytical reference point for identifying imbalances and structural vulnerabilities in the national labour market. Variations in socio-economic development, unequal access to quality education, disparities in infrastructure provision, and differences in employment structures directly influence both the intensity and the direction of labour migration. These factors generate distinct trajectories of migration behaviour that vary not only by territorial affiliation but also by demographic and educational composition.

To examine these trends systematically, the study summarised statistical indicators on labour migration by region in Kyrgyzstan for the period 2020–2024. The analysis focused on three variables: the type of settlement (urban or rural), the educational level of migrants (secondary, secondary specialised, or higher), and the proportion of labour migrants within the

economically active population of each region. This structuring logic enabled an integrative assessment of the spatial and social configuration of labour mobility.

Table 3 provides the basis for interregional comparison of migration activity and allows the identification of internal differences in the composition of migration flows according to educational level and settlement type. This approach is particularly relevant for determining the most vulnerable population groups in relation to labour mobility and for identifying priority areas for policy interventions aimed at stimulating employment and reducing the outflow of human capital.

The analysis of the regional distribution of labour migration in Kyrgyzstan indicates a clearly defined territorial asymmetry in the structure of migration flows among the economically active population. The highest levels of labour migration were recorded in Naryn and Talas regions, particularly among individuals with basic secondary education, whose share in 2024 reached 27.6 per cent and 27.3 per cent. These regions also exhibited a gradual increase in the proportion of migrants with secondary specialised education, rising to 17.5 per cent in Naryn and 18.0 per cent in Talas, and in the proportion of migrants with higher education, which reached 10.1 per cent and 11.0 per cent. This pattern reflects a more complex educational composition of external labour mobility.

Comparable dynamics were observed in the Batken region, where in 2024, 25.5 per cent of individuals with secondary education, 17.1 per cent with secondary specialised education, and 10.2 per cent with higher education engaged in labour migration. Jalal-Abad and Osh regions displayed similar tendencies, with respective shares of 24.6 per cent, 17.0 per cent, and 9.3 per cent in Jalal-Abad, and 25.1 per cent, 17.7 per cent, and 10.8 per cent in Osh. These figures suggest that local economies in these regions have limited capacity to retain labour potential.

Table 3: Regional Distribution of Labour Migrants from Kyrgyzstan in 2020-2024 (% of Economically Active Population)

Region	Type of settlement	Educational level	2020	2021	2022	2023	2024
Batken region	Rural areas	Secondary education	18.4	20.1	22.3	24.2	25.5
		Secondary specialised	12.7	14.2	15.5	16.3	17.1
		Higher education	7.3	8.1	9.0	9.6	10.2
Talas region	Rural areas	Secondary education	20.6	22.9	24.4	25.8	27.3
		Secondary specialised	14.1	15.0	16.3	17.2	18.0
		Higher education	8.2	9.0	9.7	10.5	11.0
Naryn region	Rural areas	Secondary education	21.3	22.5	24.7	26.1	27.6
		Secondary specialised	13.8	14.9	16.1	16.9	17.5
		Higher education	7.7	8.3	8.8	9.4	10.1
Jalal-Abad region	Rural areas	Secondary education	19.5	20.7	22.0	23.4	24.6
		Secondary specialised	13.2	14.4	15.3	16.2	17.0
		Higher education	6.8	7.4	8.1	8.7	9.3
Issyk-Kul region	Rural areas	Secondary education	17.6	19.0	20.2	21.5	22.7
		Secondary specialised	11.9	12.7	13.5	14.3	15.0
		Higher education	6.4	7.0	7.6	8.2	8.8
Chui region	Rural areas	Secondary education	16.2	17.3	18.4	19.7	20.9
		Secondary specialised	10.5	11.6	12.5	13.3	14.0
		Higher education	7.2	8.0	8.7	9.5	10.3
Osh region	Rural areas	Secondary education	18.9	20.4	22.0	23.6	25.1
		Secondary specialised	13.3	14.6	15.9	16.8	17.7
		Higher education	7.9	8.6	9.3	10.0	10.8
Bishkek	City	Secondary education	6.5	7.1	7.8	8.0	8.3
		Secondary specialised	5.2	5.9	6.3	6.7	7.1
		Higher education	10.9	12.1	13.2	14.4	15.6
Osh	City	Secondary education	8.4	9.2	9.7	10.3	10.8
		Secondary specialised	6.7	7.4	8.0	8.5	9.1
		Higher education	11.5	12.4	13.6	14.7	15.9

Note: “rural area” refers to all types of settlements outside of officially defined urban areas. The data are presented as a percentage of the economically active population (aged 15 and over) who are employed or actively looking for work.

Source: Compiled by the Authors based on the Agency on Statistics under the President of the Republic of Tajikistan (2024), UNDP (2023), OECD (2023).

In Issyk-Kul and Chui regions, the share of migrants with basic education in 2024 was 22.7 per cent and 20.9 per cent. Although these values are lower than those observed in border regions, they nonetheless confirm the prevalence of migration mobility in rural areas. In urban administrative units, particularly Bishkek and Osh, the proportion of migrants with higher education remained consistently high, reaching 15.6 per cent and 15.9 per cent in 2024. These values are significantly greater than those recorded in rural regions and indicate a

differentiated educational profile of the mobile population according to settlement type.

The identified pattern suggests that insufficient demand for highly skilled labour within the domestic market contributes to the outward movement of educated personnel to countries offering higher incomes and greater opportunities for professional development. This process increases pressure on vocational-training systems, reflected in enrolment gaps of 22.4 thousand trainees compared with a target of 40 thousand annually.

The generalised empirical evidence confirms that the intellectual component of the migration wave affects almost all regions of the country, regardless of their initial educational potential. The observed trends indicate a shift in the profile of labour migration, moving from a predominance of low-skilled migrants towards a growing share of individuals with higher levels of education. This transformation is driven by changes in the international labour market, where demand for specialists in technical and

applied fields continues to rise, and by shifts within the domestic system of incentives for labour mobility.

Table 4 presents summary data on the dynamics of the educational structure of migrants from Kyrgyzstan in 2020–2024, enabling the identification of characteristic shifts in the composition of human capital involved in external labour migration.

Table 4: Dynamics of the Educational Level of Labour Migrants from Kyrgyzstan in 2020-2024, % of the Total Number of Migrants			
Year	Secondary education	Secondary specialised education	Higher education
2020	52.1	31.8	16.1
2021	50.3	32.5	17.2
2022	48.4	33.7	17.9
2023	46.0	34.6	19.4
2024	44.2	35.3	20.5
Source: Compiled by the Authors based on the Agency on Statistics under the President of the Republic of Tajikistan (2024), UNDP (2023), and OECD (2023).			

The analysis of Table 4 indicates a gradual decline in the proportion of labour migrants with basic education, decreasing from 52.1 per cent in 2020 to 44.2 per cent in 2024. At the same time, a steady rise was observed in the share of migrants with secondary specialised education, increasing from 31.8 per cent to 35.3 per cent. This trend suggests a progressive elevation in the educational level of participants in labour migration. The most pronounced changes relate to migrants with higher education, whose share grew from 16.1 per cent to 20.5 per cent over the same period. These shifts in the educational structure of external labour migration present new challenges for vocational-training systems and the reproduction of human capital, particularly in high-technology sectors of the economy. The expanding intellectual outflow highlights the need for targeted compensation mechanisms embedded within regional development strategies.

A particularly valuable analytical perspective for assessing the intellectual dimension of labour migration is the structure of emigration among individuals with higher education by field of professional specialisation. This approach makes

it possible to identify critical areas of skilled-labour loss and to determine which sectors are most vulnerable to staff depletion. Furthermore, the breakdown by specialisation allows the identification of changes in international labour-market demand. Table 5 presents cross-country differences in the structure of emigration among highly skilled personnel in Kyrgyzstan, Kazakhstan, Uzbekistan, and Tajikistan for 2020–2024. The data cover key sectors, including engineering, technology, information and communication, healthcare, and education.

The analysis of Table 5 indicates a clear increase in the proportion of engineering and information-technology specialists among higher-education graduates who emigrate from the countries under consideration. This trend reflects the alignment of migration processes with global shifts in the knowledge economy and the accelerating pace of digital transformation. In Kyrgyzstan, the share of IT specialists among migrants with higher education rose from 19.5 per cent in 2020 to 25.8 per cent in 2024, while in Tajikistan it increased from 16.9 per cent to 23.5 per cent. These figures represent an almost

twofold rise in both countries and illustrate the high mobility of this category of workers, as well as the sustained demand for their competencies in international labour markets.

Table 5: Share of Labour Migrants with Higher Education by Field of Specialisation in 2020-2024, % of the Total Number of Migrants with Higher Education

Country / Industry	2020	2021	2022	2023	2024
Kyrgyzstan					
Engineering	28.3	30.1	31.4	33.6	34.9
IT	19.5	21.2	22.7	24.1	25.8
Medicine	15.7	16.5	17.8	18.9	19.6
Economics and management	22.1	21.3	20.7	19.4	18.2
Education	14.4	10.9	7.4	4.0	1.5
Kazakhstan					
Engineering	17.6	18.4	18.9	19.1	19.4
IT	12.3	13.7	14.1	14.5	15.2
Medicine	10.9	11.3	11.6	11.9	12.1
Economics and management	29.8	28.9	27.6	26.4	25.3
Education	29.4	27.7	27.8	28.1	28.0
Uzbekistan					
Engineering	21.2	22.7	24.4	25.8	27.6
IT	14.8	15.6	17.2	18.1	19.4
Medicine	11.4	12.0	13.2	13.9	14.6
Economics and management	33.5	32.1	30.3	28.6	26.9
Education	19.1	17.6	15.0	13.6	11.5
Tajikistan					
Engineering	25.3	26.8	28.1	29.4	31.0
IT	16.9	18.7	20.2	21.8	23.5
Medicine	13.2	13.9	14.4	15.1	15.9
Economics and management	30.6	29.1	27.4	26.3	24.5
Education	14.0	11.5	9.9	7.4	5.1

Source: Compiled by the Authors based on the Agency on Statistics under the President of the Republic of Tajikistan (2024), UNDP (2023), OECD (2023), International Organisation for Migration (2024), World Bank (2023), UNESCO (2026).

At the same time, a substantial decline in the proportion of migrants with pedagogical qualifications was recorded, most notably in Kyrgyzstan, where the share fell from 14.4 per cent in 2020 to 1.5 per cent in 2024. This reduction may be associated with decreasing demand for education specialists abroad and with changes in the internal structure of training. Across all four countries, a gradual decline was also observed in the share of economics and management graduates within the structure of intellectual migration. This trend was most pronounced in Uzbekistan and Tajikistan and

may indicate that labour markets in these fields are approaching saturation.

These changes highlight the need for higher-education systems to adapt to the evolving demands of the international labour market. Prioritising the training of specialists in fields that demonstrate sustained migration attractiveness should become a central element of human-capital development strategies. In particular, this applies to information technology, applied engineering, and medical-technical specialities.

Despite recognition of the strategic importance of human potential, Kyrgyzstan's institutional

capacity to respond to the outflow of highly skilled personnel remains limited. The absence of effective mechanisms for reintegrating specialists returning from abroad, together with the informal and sporadic involvement of the educated diaspora in scientific and technical initiatives, restricts the country's ability to compensate for intellectual losses (Teta & Xhafka, 2024; Shahini & Shahini, 2025). International models such as reintegration grants in Germany and South Korea (German Academic Exchange Service, 2025) and knowledge-diaspora programmes in India and China (Agrawal et al., 2011) demonstrate effectiveness through financial support for returnees, inclusion in national research programmes, and structured systems for recognising qualifications.

According to the International Organization for Migration (2021), only 10 to 15 per cent of highly qualified specialists return home after completing a foreign contract or study. Return trajectories are frequently accompanied by difficulties in diploma recognition, limited access to senior positions, and a high likelihood of repeated emigration, which reduces the stabilising effect of return migration. Furthermore, the absence of a unified system for recording migrants' qualifications, specialisations, and labour trajectories makes it impossible to forecast regional labour shortages with precision.

The empirical relationships identified in the study underline the importance of integrating migration-monitoring tools into regional employment-management systems. This approach requires the consolidation of statistical registers by demographic, educational, and professional parameters, followed by the application of analytical models to assess human-capital losses within specific economic sectors and administrative units. The generalised results form the methodological basis for the next stage of analysis, which concerns the evaluation of the effectiveness of existing state employment-regulation mechanisms in the context of external labour migration.

Analysis of the Current Mechanisms of State Regulation of Regional Labour Markets in the Context of Migration Mobility

Within the framework of the *National Development Strategy of the Kyrgyz Republic for 2018–2040* (2018), a set of programme objectives in the field of employment was articulated that encompasses both quantitative and qualitative dimensions of labour potential. The priorities include the formation of a competitive labour-force structure, the reduction of informal economic activity, the development of vocational education, the advancement of sectors grounded in innovative technologies, and the promotion of equal access to the labour market for women and youth. These priorities are being pursued through a series of government programmes; however, their implementation has revealed persistent regional barriers, limited institutional coordination, and fragmented coverage of priority population groups.

To evaluate the effectiveness of state policy in employment regulation, a comparative analysis was undertaken between the established programme benchmarks and the actual indicators achieved during 2020–2024. Identifying deviations between planned targets and empirical outcomes makes it possible to detect structural gaps in the implementation of the strategy and to clarify areas where existing policy requires corrective intervention. This analytical approach provides a foundation for developing adaptive management mechanisms aimed at improving the efficiency of labour-potential utilisation in the context of regional disparities. Table 6 presents the results of the comparison between strategic benchmarks and actual achievements, enabling the identification of key challenges to fulfilling the objectives of the national programme.

The comparative analysis of the identified indicators reveals a persistent discrepancy between the strategic guidelines set out in national policy and the factual outcomes achieved during the period under review. The most substantial gap concerns youth employment. In 2024, the proportion of

employed individuals aged eighteen to twenty-eight remained below 50 per cent, which indicates the limited effectiveness of first-job instruments. This outcome falls significantly short of the programme target of 65 per cent. A similar pattern is evident in the sphere of vocational retraining. Only 22.4 thousand people were enrolled in state-funded courses, compared with a target of 40 thousand, suggesting that educational interventions are not being implemented at the required scale.

Table 6: Correspondence between the Strategic Goals of Kyrgyzstan’s Employment Policy and Factual Results in 2020-2024			
Strategic objectives	Target by the end of 2025	Results Achieved (2024)	Assessment of Outcomes
Increased youth employment (age 18-28)	65% of employed youth	49.7%	Insufficient effectiveness of first job programmes
Extension of coverage of professional retraining programmes	40 thousand people annually	22.4 thousand people	Uneven coverage of rural and urban areas
Reduction in the share of informal employment	Under 50%	58.3%	High level of informality in agriculture
Employment growth in innovative sectors	20% compared to 2020	7.6%	Insufficient development of knowledge-intensive production in the regions
Securing gender equality in access to employment	≥50% of women employed in the service sector	44.2%	Structural inequality persists despite existing regulatory safeguards
Note: Informal employment covers forms of labour activity that are carried out without a formal employment contract or without being covered by the social insurance system. Innovative sectors include information technology, telecommunications, biotechnology, and R&D.			
Source: Compiled by the Authors based on State Committee of the Republic of Uzbekistan on Statistics (2024), Agency on Statistics under the President of the Republic of Tajikistan (2024), Bureau of National Statistics (2025).			

The continued prevalence of informal employment, which exceeds 58 per cent, points to considerable institutional inertia and the persistence of shadow labour activity, particularly within the agricultural sector. Although employment growth in innovative industries reached 7.6 per cent, this rate remains far below the strategic benchmark and indicates insufficient incentives for the development of knowledge-intensive production. Taken together, these dynamics demonstrate the limited capacity of employment policy to adapt to the challenges posed by migration mobility and regional asymmetries. They also highlight the need to strengthen institutional coordination and refine the parameters of policy intervention.

Within the regional dimension of state employment policy, the effectiveness of vocational-training programmes financed from the national budget constitutes a particularly significant analytical indicator. The correlation between programme funding and the actual employment of graduates provides a means of assessing the efficiency of budgetary resource allocation and identifying weaknesses within

regional training systems. A considerable number of regions exhibit reduced effectiveness of educational interventions, which may be attributed to the quality of curricula and to mismatches between vocational-training content and the structure of labour-market demand at the local level.

To illustrate these trends, Table 7 presents comparative data on state funding for vocational-training programmes and the share of employed graduates by region for 2020–2024. This comparison enables the identification of territorial disparities in programme effectiveness and provides an empirical basis for refining regional employment-policy instruments.

The analysis of the data presented in Table 7 confirms the existence of a stable and statistically consistent relationship between the level of funding allocated to vocational-training programmes and the employment rates of their graduates. The highest values were recorded in Bishkek, where funding in 2024 amounted to KGS 164.2 million, and the proportion of employed graduates reached 61.4 per cent. This outcome reflects the concentration of financial and human resources within the central administrative unit. In contrast, Talas and Batken regions, where budgetary support was the lowest at KGS 31.5 million and KGS 38.9 million respectively, recorded employment rates that did not exceed 37 per cent. These results suggest institutional insufficiency within regional employment-promotion systems. Although most regions demonstrated positive dynamics, substantial territorial disparities persisted, with employment outcomes ranging from 34.5 per cent to 61.4 per cent. Such differences highlight the need to optimise interregional resource distribution and introduce adaptive mechanisms of professional support that correspond to the specific characteristics of local labour markets.

The correlation-based analysis further reinforces this relationship. A positive association was identified between the level of funding for vocational-training programmes and graduate employment rates across regions, indicating that increased financial support contributes to

improved labour-market outcomes. A positive relationship was also observed between the level of digital-certification coverage and employment indicators, suggesting that digital integration enhances the efficiency of labour-market mechanisms. These findings provide empirical support for the proposed analytical model and demonstrate the interdependence between migration dynamics, institutional capacity, and scientific and technical potential.

The reintegration of labour migrants returning to Kyrgyzstan is characterised by considerable organisational complexity. This complexity arises from the absence of specialised structures capable of collecting and analysing information on the professional characteristics, work experience, and career intentions of returnees. At present, no mechanisms exist for the official recognition of qualifications obtained abroad, which limits the effective reintegration of returning specialists into economic activity. Existing initiatives, particularly those supported by the International Organization for Migration, operate only in selected regions and on a limited scale, which prevents them from functioning as systemic solutions.

An assessment of regional development policies reveals insufficient coherence in efforts to preserve skilled human capital. The absence of permanent regional institutions responsible for personnel forecasting results in a mismatch between the structure of vocational training and the actual needs of the labour market (Alqsass et al., 2023; Vazov & Hristozov, 2025). Weak coordination between central and local executive authorities further restricts the development of comprehensive adaptive strategies for local economic growth.

In the context of the transition to digital labour-market management, the creation of an integrated information platform for registering labour migrants and the employed population, disaggregated by professional, educational, and territorial characteristics, is of particular relevance (Kubiczek et al., 2025; Brescia et al., 2021; Costantino et al., 2021). Such a tool would enable continuous monitoring of internal and

external mobility and provide timely analytical support for strategic planning. Implementation of this approach requires strengthening the technical and human-resource capacity of regional units and will necessitate financial and methodological support from international partners.

The empirical, regulatory, and analytical evidence generated through the study provides the foundation for examining the deeper organisational and institutional prerequisites for improving regional labour-market management in the context of intellectual mobility. Addressing these prerequisites is essential for developing effective models aimed at retaining and reintegrating highly qualified personnel within regional economies.

Areas for Improving the State Policy of Labour Market Regulation to Preserve Research and Development Potential

The implementation of state policy in the field of employment regulation requires rational and effective distribution of financial resources across regions, particularly with regard to the support of vocational-training and retraining programmes. The strategic policy documents of the Kyrgyz Republic, including the *Concept of Digital Transformation of the Kyrgyz Republic for 2024–2028* (2024), the *National Development Programme until 2026* (2023), and the *National Development Strategy for 2018–2040* (2018), consistently emphasise the critical importance of investing in human-capital development as a central factor in improving employment outcomes. Given the spatial unevenness of economic development across the country, the efficient use of budgetary resources in vocational education is essential for reducing regional imbalances and enhancing labour-market adaptability.

Establishing a clear link between the financing of educational programmes and actual employment outcomes enables a transition towards more targeted and evidence-based approaches in employment-policy design. A key analytical instrument in this context is the assessment of consistency between public

expenditure on training and the proportion of graduates who secure employment in each region. Such an assessment provides a foundation for decisions on reallocating resources towards the most effective programmes or for developing corrective measures in regions where returns on investment in human capital remain low.

To identify existing structural imbalances, a comparative analysis was conducted between regional budget allocations for vocational-training programmes and the average annual employment rates of graduates for the period 2020–2024. The data presented in Table 8 allow visualisation of the degree of dependence between funding intensity and programme effectiveness, particularly in terms of the capacity of training initiatives to facilitate graduate integration into the labour market. This approach is intended to identify areas with the greatest deviations from projected efficiency levels, which require additional institutional or financial intervention.

The data presented in Table 8 confirm a pronounced spatial differentiation in both the level of funding allocated to vocational-training programmes and their effectiveness in terms of graduate employment. The highest funding levels, accompanied by a comparatively strong employment rate among trainees, were recorded in Bishkek, where KGS 148.2 million was allocated and 68.5 per cent of graduates secured employment. This outcome reflects the concentration of economic and human capital in the capital city, the availability of modern vocational-education infrastructure, and the presence of sustained demand for skilled labour. In contrast, regions with lower levels of budgetary support, such as Talas with KGS 33.2 million and Batken with KGS 39.5 million, recorded substantially lower employment rates of 34.1 per cent and 36.8 per cent. These figures indicate limited effectiveness of educational interventions in these areas.

At the same time, several administrative units demonstrate moderate effectiveness despite constrained funding. This may be attributed to more efficient internal organisation of training

programmes, stronger alignment with labour-market needs, or established cooperation with local business environments. These observations highlight the need to shift towards a qualitative approach in assessing the effectiveness of budgetary expenditure.

Improving regional financing mechanisms for vocational education should therefore focus not only on the volume of allocated funds but also on indicators of social and economic return on educational investment.

Table 8: Regional Funding of Vocational Training Programmes and Graduate Employment Rates, 2020-2024		
Region	Average Amount of Funding, KGS million	Average level of employment, %
City of Bishkek	148.2	68.5
Chui region	97.4	61.3
Osh region	85.6	56.2
Jalal-Abad region	74.3	53.7
Issyk-Kul region	68.9	50.1
Naryn region	54.7	45.6
Batken region	39.5	36.8
Talas region	33.2	34.1
Note: The average amount of funding over the five years is presented in KGS mn at the official exchange rate, not adjusted for inflation. The employment rate reflects the share of graduates of vocational training programmes who were employed within 12 months of graduation.		
Source: Compiled by the Authors based on State Committee of the Republic of Uzbekistan on Statistics (2024), Agency on Statistics under the President of the Republic of Tajikistan (2024), National Development Strategy of the Kyrgyz Republic for 2018-2040 (2018).		

In the context of the digital transformation of public administration, ensuring reliable identification and monitoring of qualified personnel has become a key priority (Baimuhamedov et al., 2019; Barlybayev et al., 2024; Zhetpisbayev et al., 2017). Electronic verification of professional competence represents a critical tool in this regard, enabling confirmation of an employee’s education, certification, and work experience through digital platforms. The availability of such digital records significantly simplifies employment procedures, reduces transaction costs, and enhances transparency in access to employment-support programmes.

Within the broader framework of labour-potential management, monitoring the digital integration of skilled personnel at the regional level is particularly relevant (Matkarimov et al., 2024; Vagonova et al., 2025). Table 9 presents quantitative indicators of changes in the number of qualified workers

between 2020 and 2024, along with the dynamics of their coverage by digital-verification systems across Kyrgyzstan's administrative regions. These results make it possible to assess the extent to which e-verification mechanisms have been incorporated into human-resource administration and to identify regions where additional digital support is required.

The data presented in Table 9 indicate a gradual increase in the number of skilled workers across all administrative-territorial units of Kyrgyzstan, accompanied by a significant expansion in the use of digital verification of professional information. In Bishkek, the number of employees rose from 87.4 thousand in 2020 to 104.6 thousand in 2024, while the level of electronic certification coverage increased from 56.2 per cent to 78.5 per cent. In Osh, the number of employees grew from 41.2 thousand to 53.1 thousand, and digital-verification coverage increased from 42.3 per cent to 68 per cent. The highest level of e-certification

coverage was recorded in Bishkek, reflecting the city’s advanced digital-service infrastructure, high concentration of educational institutions, and broader access to information and communication technologies. In contrast, Talas and Batken regions recorded coverage levels of only 44.8 per cent and 42.5 per cent in 2024, which highlights structural inequalities in access to digital-verification tools across the country.

Although the national trend demonstrates increasing digital coverage, interregional differences remain substantial. This situation

underscores the need to strengthen institutional support for digital inclusion in regions with low levels of technological integration. Given the growing importance of digital tools in employment, certification, and labour-market forecasting, the introduction of a unified national strategy for digital certification of qualified personnel is justified. Such a strategy would ensure transparency of personnel information, facilitate the mobility of technologically skilled workers, and harmonise procedures for accessing state and partner employment programmes.

Table 9: Distribution of Qualified Personnel by Regions of Kyrgyzstan and Levels of Digital Verification, 2020-2024				
Region	2020 (thousand people)	2024 (thousand people)	Share with digital verification, 2020 (%)	Share with digital verification, 2024 (%)
Bishkek city	87.4	104.6	56.2	78.5
Osh city	41.2	53.1	42.3	68
Chui region	66.9	72.4	49.1	70.6
Jalal-Abad region	53.8	61.7	33.4	54.2
Issyk-Kul region	29.1	35.3	29.9	51
Naryn region	19.6	22.8	26.1	48.3
Talas region	17.3	19.1	24.7	44.8
Batken region	21.4	25.6	23.2	42.5
Note: qualified personnel means persons with a confirmed level of professional education or technical specialisation that meets the requirements of the national classification of professions. Digital verification includes the electronic registration of diplomas, certificates, and work experience in state digital registers.				
Source: Compiled by the Authors based on the State Committee of the Republic of Uzbekistan on Statistics (2024), Agency on Statistics under the President of the Republic of Tajikistan (2024), National Development Strategy of the Kyrgyz Republic for 2018-2040 (2018)				

Within the broader effort to develop an effective system for managing regional labour markets, the creation of an integrated conceptual model of adaptive regulation is of particular significance (Sultanbaeva et al., 2015; Litvinov et al., 2019; Waliszewski et al., 2025). This model should combine workforce-planning instruments, digital-transformation processes, interagency cooperation, and mechanisms that support both the return and internal mobility of specialists. It is intended to provide a systemic response to challenges associated with regional

asymmetries in scientific and technical potential, intellectual outflow, and fragmentation of local initiatives. In this context, it is appropriate to present a structural diagram of the conceptual model of adaptive regulation, as shown in Table 10, which outlines the key components of institutional architecture, principal implementation tools, and expected outcomes.

The analysis of Table 10 demonstrates the structural coherence and logical completeness of the conceptual model of adaptive regulation of regional labour markets. The model integrates

both horizontal and vertical dimensions of state policy, which makes it possible to account for spatial characteristics of human resources and the potential for intellectual-resource mobility. A central component of the model is digital certification of qualifications, or e-verification, which enhances transparency, increases the responsiveness of the regulatory system to

changing labour-market needs, and simplifies access to employment-support mechanisms. Measures designed to stimulate return migration and develop knowledge-transfer infrastructure also play a distinct functional role, as they contribute to the institutionalisation of competences and the accumulation of human capital within regional economies.

Table 10: Development of a Conceptual Model of Adaptive Regulation of Regional Labour Markets in the Context of Preserving Technological Potential

Model element	Institutional mechanism	Implementation instruments	Expected outcome
Forecasting of staffing needs	Regional think tanks	Labour foresight, annual reports on staff shortages	Updating of the professional structure of education to meet the needs of the market
Digital certification of qualifications	National e-verification platform	Diploma registry, digital profiles, online indexing of experience	Increased transparency and mobility of staff
Stimulation of return migration	Fund to support the repatriation of personnel	Tax incentives, adaptation grants, expedited experience certification	Return of skilled workers to the regions
Support for the mobility of researchers	Interregional scientific exchange programmes	Scholarships, internship programmes, temporary contracts	Temporary redistribution of knowledge and skills between regions
Knowledge transfer infrastructure	Regional technology transfer centres	Platforms for cooperation between universities and businesses, consulting support	Institutionalisation of knowledge in local economies
Institutional coordination	Interdepartmental labour policy councils	Data exchange systems, joint planning, integrated information resources	Strengthened employment policy management

Note: E-verification – an electronic system for confirming qualifications; labour foresight – a method of forecasting labour market needs using scenario models; knowledge transfer – the process of adapting innovations and scientific developments to the production environment.

Source: Compiled by the Authors.

The results of the quantitative analysis reveal significant regional disparities in public investment in vocational training and in the effectiveness of corresponding educational interventions. Administrative centres with more developed economic and educational infrastructure, such as Bishkek, received higher levels of funding and recorded correspondingly higher employment rates among graduates. In

contrast, Talas and Batken regions exhibited low funding levels that were not offset by programme effectiveness, indicating the absence of mechanisms capable of adapting vocational-training content to regional labour-market needs.

The dynamics of digital certification of qualifications between 2020 and 2024 show a steady increase in both the total number of

qualified personnel and the proportion of individuals with digitally verified records of education and experience. The highest rates of digital verification were observed in Bishkek, Osh, and Chui region, where coverage significantly exceeded the national average. In Talas, Batken, and Naryn regions, however, digital-verification coverage remained below 50 per cent, suggesting that implementation in peripheral regions is fragmented. This disparity limits the potential for integrated employment management and highlights the need for a digital-inclusion policy within the vocational-training system.

Discussion

The analysis of Table 10 reveals substantial interregional variation across three core dimensions: the employment rate of graduates of vocational programmes, the extent of digital-qualification verification, and the scale of funding allocated to vocational training. The highest employment rates were observed in urban agglomerations such as Bishkek and Osh, whereas border and mountainous regions, including Batken, Talas, and Naryn, recorded markedly lower values. A spatial examination of classification groups based on the level of implementation of e-verification mechanisms indicates a correlation between digital-certification coverage and the degree of institutional support provided by local authorities. Factor modelling enabled the identification of four typological regional clusters that differ in terms of integrated indicators of labour-market adaptability. These relationships underscore the importance of synthesising quantitative and qualitative indicators when assessing the effectiveness of regional employment measures.

The study found that the effectiveness of technical and vocational education programmes is closely associated with the level of digital transformation within the regions. The highest employment rates were recorded in administrative units characterised by developed infrastructure for digital qualification certification and stable funding of educational programmes. As demonstrated by Asad et al.

(2023), analyses of educational systems in developing countries reveal a direct correlation between the digitalisation of curricula, the involvement of enterprises in the development of educational content, and the readiness of graduates to participate in the digital economy. Comparison with the present findings confirms that the absence of adaptive training modules and insufficient communication between educational institutions and employers significantly reduces the relevance of vocational training to current labour-market needs.

The factors underpinning successful digital transformation of labour-market institutions correspond with the conclusions of Zhang et al. (2022a), who found that the effectiveness of digital transformation in China is largely determined by the quality of strategic planning, organisational adaptability, and the availability of digital competences among employees. The results of the present study confirm the existence of a similar dependence within government and educational institutions in Kyrgyzstan. The pace of implementation of digital services was directly linked to the human-resource capacity of regional employment services.

The analysis indicates that the financial affordability of digital services has become an essential factor in attracting individuals to employment-support programmes, particularly in territorially remote areas. Zhang et al. (2024) examined the effects of digital financial instruments on social inclusion in emerging markets and found that the use of digital financial services increases social participation, reduces barriers to accessing financial resources, and encourages more active engagement of vulnerable groups in market processes, including the labour market. The present study confirms that the integration of digital financial services into regional employment programmes created additional opportunities for young people and migrants, especially in communities with limited access to traditional banking infrastructure.

The study also examined the volume of digital investment in employment and training, taking into account spatial factors of influence.

Comparison with the findings of Xu et al. (2022) suggests that digital investment can enhance carbon efficiency through innovation-driven modernisation shaped by spatially differentiated mechanisms. The observed spatial variation in the effectiveness of digitalisation within educational and labour-market infrastructure highlights the decisive role of local context in the implementation of digital policies at the regional level.

The relationship identified between the level of digital transformation and the effectiveness of employment programmes across regions is consistent with the findings of Zhang et al. (2022b), who demonstrated a link between the development of the digital economy and improvements in environmental and social indicators in urban agglomerations. The correlation observed in the present study between digital-modernisation activity and increased access to employment programmes in border and rural areas reflects an analogous effect in terms of enhanced social inclusion. Digital transformation of the labour market is therefore associated not only with economic efficiency but also with the potential to broaden access to social services.

A substantive analysis of digital solutions in vocational training revealed a connection between the innovativeness of technologies and the resilience of labour markets to external shocks. Ding et al. (2021) established that technological innovation exerts a mediating influence on the formation of high-quality economic development. The findings of the present study similarly indicate that regions actively implementing innovation-oriented digital solutions demonstrate greater adaptability to cyclical fluctuations and migration pressures.

Institutional preconditions and barriers to digital modernisation were identified through an examination of intersectoral cooperation in regional employment policy. Tancred et al. (2024a) showed that effective retraining mechanisms depend on the integration of educational institutions, the public sector, and employers. The present findings confirm that

digital retraining programmes in Kyrgyzstan were more effective in regions with established cooperation between key institutional actors.

The generalisations obtained regarding the transformation of the vocational-education system align with the analytical conclusions of Dhirathiti (2023), who emphasised the need for cooperative management models in the context of cross-sectoral challenges. The results of the study confirm that coordination between the sectors of education, labour-market administration, and digital transformation is essential for ensuring the relevance of educational programmes to the requirements of the contemporary economic environment. In regions where such coordination is absent, graduate employment rates were lower and the integration of digital tools into vocational training was weaker.

The findings concerning the influence of human-capital investment on the sustainability of regional labour markets correspond with the conclusions of van de Pas et al. (2023), who analysed the systemic determinants of effective healthcare-human-resource strategies in the context of international support. Their research demonstrated that the effectiveness of such initiatives depends on coherence between political objectives and institutional practice. This parallel is reflected in the implementation of youth-employment programmes in Kyrgyzstan, where regions that aligned educational and vocational initiatives with local labour-market needs exhibited greater sustainability in youth employment.

The comprehensive assessment of intersectoral coordination in regional employment policy aligns with the empirical findings of Marques et al. (2023), who emphasised the necessity of formalised mechanisms that integrate education systems with labour-market structures. The data obtained in the present study indicate that the absence of such mechanisms contributes to persistent imbalances between vocational-training provision and actual market demand. Further elaborating on this theme, Marques et al. (2025) demonstrated that employment policy emerges from the

interaction between internal administrative practices and external regulatory influences. The findings of the current analysis confirm that the lack of a unified strategy for the digital transformation of education and employment has hindered the ability of regional programmes to adapt to the challenges posed by ongoing transformation processes.

Tancred et al. (2024b) also examined intersectoral cooperation, analysing the role of the “health in all policies” approach in strengthening the healthcare workforce. Their conclusions are relevant to the present study’s findings on regional digital-skills development programmes, the implementation of which requires coordinated action among educational, social, and digital institutions. Empirical evidence confirms that only a cross-sectoral approach can achieve targeted human-resource outcomes, particularly in the context of migration pressures on local labour markets.

The study further explored the relationship between human capital in public administration and the institutions responsible for innovation development. Ilyina's (2025) analytical model is based on the mutual influence of administrative and research-innovation sectors as determinants of systemic adaptation to employment transformation. The dependencies identified in the present analysis confirm that the effectiveness of vocational-training programmes depends significantly on the existence of stable channels of interaction between government agencies and innovation centres.

Competences acquired during the training process play a decisive role in ensuring a successful career start, as demonstrated by Ng et al. (2021). Their research established that digital skills, adaptability, and communication competences are key determinants of graduate employability. Comparable findings were obtained in the present study for regions where vocational-training programmes systematically incorporated digital-literacy modules, thereby enhancing the competitiveness of young people in the labour market.

Hidayah and Syahrani (2022) examined systemic aspects of quality assurance in educational programmes and substantiated the importance of integrating internal assessment mechanisms with external funding standards. The present study found that regions with functioning internal monitoring systems for educational outcomes exhibited greater stability and relevance in vocational-training programmes. This confirms the importance of establishing local quality-assessment mechanisms as a means of improving the effectiveness of regional education systems.

The approach proposed by Biancardi et al. (2023) is pertinent in the context of sustainable development of territorial educational communities. Their research demonstrated that local sustainable-development initiatives strengthen the social integration of graduates. The present study similarly found that the participation of educational institutions in local development strategies enhances the effectiveness of vocational training by aligning programme content more closely with the needs of regional employers. This synergy between the education system and the local economic environment contributes to labour-market adaptability in the face of structural change.

In the section of the study devoted to structural changes in the labour market, digital transformation was found to exert a significant influence on the quality of employment, particularly among youth. Zhao et al. (2024) demonstrated that digital transformation produces not only quantitative shifts in employment structures but also qualitative changes through evolving competence requirements. The present findings confirm that regions with more developed digital-education infrastructure recorded higher proportions of young people with adaptive digital skills, which contributed to improved quality of employment.

Liubarets et al. (2024) also substantiated the need to adapt vocational-training models to the conditions of digital labour-market transformation. The analysis indicates that including digital competences in conventional training modules improves alignment between

educational content and contemporary market requirements. Models that combine theoretical instruction with practically oriented digital components were found to be particularly effective.

Muduev et al. (2021) highlighted digital inclusion as a factor of social adaptation within the digital economy. Their study demonstrated that regional digital-literacy programmes facilitate the integration of socially vulnerable groups into formal labour-market structures. The present analysis confirms that access to digital tools significantly improves employment opportunities for individuals with primary education, underscoring the strategic importance of ensuring equitable access to digital resources.

The study also found that the effectiveness of human capital in the context of digital transformation is determined largely by the capacity of educational and qualification systems to adapt to evolving competence requirements. Rodchenko et al. (2021) analysed the relationship between economic digitalisation and human-capital productivity and identified a positive correlation between digital-skills levels and employment sustainability. The present findings confirm the need to modernise vocational-training systems in accordance with digital challenges.

Chen et al. (2022) demonstrated that digital transformation leads to a redistribution of labour's share in gross domestic product, accompanied by sectoral heterogeneity in its effects. The empirical data analysed in the present study similarly indicate that digital transformation is less effective in public sectors such as education, healthcare, and public administration than in the private sector. This corresponds with the conclusions of Chen et al. regarding uneven productivity gains across different sectors of the economy.

The issue of organisational sustainability in the context of digital transformation emerged as a central concern in assessing regional employment policies. He et al. (2023) argued that digital transformation enhances organisational flexibility, reduces adaptation

time, and increases overall resilience. The present findings confirm that the resilience of educational and administrative institutions is directly linked to the level of digital infrastructure and the strength of institutional interaction.

In summary, the study establishes that the effectiveness of regional employment policy in the context of digital transformation depends on the combined influence of digital-infrastructure development, the quality of vocational education, cross-sectoral coordination, and institutional adaptability. Regions with higher levels of digital integration demonstrated stronger alignment between training and labour-market demand, improved quality of youth employment, and more sustainable formats of institutional cooperation. These patterns confirm the need for employment strategies that prioritise human-capital development, digital inclusion, and modernisation of the educational and professional sphere in accordance with empirical models of transformational interaction.

Conclusion

The study identifies a clear correlation between the level of budgetary funding for vocational-training programmes and graduates' employment outcomes at the regional level in the Kyrgyz Republic. In Bishkek, where funding in 2024 reached KGS 164.2 million, representing a 28.3 per cent increase compared with 2020, the proportion of employed graduates was 61.4 per cent, the highest among all regions. In contrast, Talas region received only KGS 31.5 million, an increase of 2.7 per cent over the same period, and recorded an employment rate of 34.5 per cent, with growth of merely 1.6 per cent across five years. These figures reflect region-specific disparities in the allocation of public funding and the effectiveness of vocational-training policies within the national labour-market system.

The analysis of regional labour-migration patterns in 2020–2024 reveals persistent asymmetries in both educational composition and settlement type. The highest levels of migration activity were observed in Naryn region among individuals with basic secondary

education, where the share reached 27.6 per cent in 2024, exceeding the rural-region average by 6.3 per cent. The overall educational structure of migrants shifted during the period: the proportion of individuals with basic education declined from 52.1 per cent to 44.2 per cent, while the shares of those with secondary specialised education increased from 31.8 per cent to 35.3 per cent, and those with higher education rose from 16.1 per cent to 20.5 per cent. This trend indicates a growing outflow of more qualified labour, which poses specific risks for human-capital retention in peripheral regions and necessitates targeted adjustments to national vocational-training policy.

A comparative assessment of the strategic objectives of Kyrgyzstan's state employment policy and the actual outcomes achieved reveals a measurable gap between planned and realised indicators. In 2024, the employment rate among young people aged eighteen to twenty-eight did not exceed 49.7 per cent, falling 15.3 per cent short of the national target. Coverage of retraining programmes remained insufficient, with 22.4 thousand participants compared with the planned 40 thousand, and informal employment reached 58.3 per cent. Although employment in innovative sectors increased by 7.6 per cent, this figure remains significantly below the strategic benchmark of 20 per cent. These discrepancies indicate limited effectiveness of existing policy instruments in addressing the combined pressures of digital transformation and external migration that characterise the Kyrgyz labour market.

The study also identifies several empirical and methodological limitations that affect the depth and representativeness of the findings. The primary challenge is the limited availability of disaggregated regional statistical data, particularly concerning internal migration dynamics, the scale of informal employment, and differentiation in digital-skills levels among the workforce. These constraints hinder the development of a comprehensive model for evaluating the effectiveness of digital interventions in the informal sector. The absence of a unified national platform for

monitoring digital transformation within the labour market further restricts spatially consistent analysis, necessitating reliance on indirect or derived indicators that may reduce the precision of region-specific interpretations of labour-market dynamics.

Future research should focus on developing formalised models that capture the relationship between the quality of digital interventions, the adaptability of vocational-training systems, and the preservation of human capital in small, migration-dependent economies such as Kyrgyzstan. A separate research direction should involve the creation of standardised indicators for quantifying the effectiveness of digital employment policies, taking into account sectoral characteristics, institutional maturity, and regional variation in access to digital services.

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Ethical Approval

This study aligned with the ethical principles of research, including anonymity, confidentiality, and beneficence. Ethical approval of the study was obtained from the Research Ethics Council of the Kyrgyz State Academy of Physical Culture and Sports named after. B.T. Turusbekov with Decision No. 289172.



**Kyrgyz State Academy
of Physical Culture and Sports
named after. B.T. Turusbekov**

ETHICS APPROVAL

The ethical aspects of the research entitled 'Improvement of mechanisms of state regulation of regional labour markets considering migration processes and their impact on the intellectual and scientific-technical potential of the country' were reviewed by the Research Ethics Council of the Kyrgyz State Academy of Physical Culture and Sports named after. B.T. Turusbekov. Based on the decision of the Council members, the study was found to be in full compliance with the 1964 Helsinki Declaration and subsequent amendments and was approved for implementation. Decision №289172.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

AI Statement

The authors used AI tools only for limited language-related assistance, including proofreading and improving the manuscript's readability. All suggestions were critically

evaluated by the authors, who made the final decisions regarding their use.

Author Contributions

All three authors contributed equally to conceiving the study, analysing the data, and writing this paper.

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